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Formal Harmonisation, Informal Divergence: Administrative Culture in European Public Procurement

Ehsan HATAMIAN[1]

[1] University of Economics-Varna, Bulgaria, ehsan.hatamian@ue-varna.bg

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Abstract

Purpose: This study investigates whether three decades of EU procurement harmonisation have created unified administrative practices or whether document-observable patterns persist, demonstrating proof-of-concept for transforming procurement documents into strategic intelligence addressing cross-border B2B information asymmetry. *Design/Methodology/Approach:* This study analyses 2,370 software packages and information systems public procurement notices (CPV 48000000) from 17 European countries (2023-2024) using an automated Cultural Intelligence Extraction System (CIES), achieving 95.4% expert validation accuracy. One hundred one parameters across twelve dimensions are extracted. ANOVA with effect-size prioritisation (η^2) and hierarchical multi-level clustering are employed. *Findings:* Document-observable patterns demonstrate extreme variation despite harmonisation: 8.8× verbosity range, 10.1× technical specification range, 5.6× scope range, with country explaining 50% of transparency variance ($\eta^2 = 0.500$). Multi-level clustering identifies five procurement strategies: Extreme Verbosity (Hungary), Multi-Domain Integration (Romania), Efficient Minimalism (a cross-regional cluster of Czech, Finland, and Switzerland), Western/Nordic Mainstream (comprising nine countries), and Eastern/Southern Moderate Complexity (Bulgaria, Greece, and Poland). Economic analysis reveals a multi-lot value paradox: 20% of tenders capture 72% of contract value, with a 294-fold variation in value concentration. *Research Implications:* The results validate institutional theory's formal/informal distinction: EU directives harmonise legal procedures while administrative practices diverge. Findings enable a document-to-intelligence transformation, providing suppliers with market selection guidance, authorities with efficiency benchmarking, and policymakers with frameworks to distinguish harmonisable dimensions from legitimate diversity. *Originality/Value:* Large-scale automated administrative pattern extraction demonstrating systematic document-to-intelligence transformation for B2B strategic positioning. A hybrid LLM-rule-based system with anti-hallucination validation establishes a methodological blueprint for extracting procurement intelligence at scale.

Keywords:

Public procurement,
Administrative culture,
Cross-national comparison,
European Union,
Tenders electronic daily,
Large language models,
Procurement harmonisation,
Hierarchical clustering

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1. Introduction

1.1 The European Procurement Paradox

European public procurement operates under harmonised regulations set out in EU Directives 2014/24/EU and 2014/25/EU (European Union, 2014a, 2014b). These directives build upon regulatory integration that dates back to the 1990s, reflecting sustained efforts to create a unified European procurement framework. The institutional convergence literature (DiMaggio & Powell, 1983) predicts that extensive regulatory harmonisation should lead to convergence in administrative practices. Nevertheless, practitioner experience suggests otherwise. German authorities emphasise legal formalism and detailed documentation (Wollmann, 2021). Swedish agencies produce remarkably concise tenders (Rothstein & Teorell, 2008). Hungarian procurement generates exhaustive specifications (Meyer-Sahling, 2009). Romanian authorities bundle multiple domains emphasising digital submission (Preda & Simion, 2019). Research Question: Has three decades of regulatory harmonisation produced cultural convergence in European public procurement, or do national practices persist despite common legal frameworks?

1.2 Research Gap and Contribution

Prior research on European procurement focuses primarily on legal compliance and directive implementation (Bovis, 2012), leaving administrative cultural dimensions underexplored. Existing comparative studies typically examine 2-5 countries qualitatively (Patrucco, Luzzini, & Ronchi, 2016), which limits statistical generalizability and hinders the systematic identification of cross-national patterns on a larger scale. This study addresses these gaps through a systematic quantitative comparison across 17 European countries, analysing 2,370 software packages and public procurement notices (CPV 48000000) for information systems from 2023 to 2024. The controlled domain focus ensures comparability, while recent data captures contemporary post-pandemic practices following the 2014 directive modernisation. Geographic diversity encompasses Western, Northern, Southern, Eastern, and Central Europe, enabling tests of whether procurement practices cluster by proximity or transcend borders through shared administrative cultures. Methodologically, this research introduces an automated Cultural Intelligence Extraction System (CIES) that extracts 101 parameters across 12 administrative dimensions, achieving an expert accuracy of 95.4%. The hybrid LLM-rule-based architecture addresses documented limitations of large language models in numerical precision while leveraging semantic extraction capabilities. Multi-level hierarchical clustering reveals administrative patterns operating at both the country and strategic-cluster levels. At the same time, effect size prioritisation (η^2 over p-values) emphasises practical significance, given the large sample's statistical power. Theoretically, the results validate institutional theory's formal/informal institution distinction (Hall & Taylor, 1996; North, 1990): EU directives harmonise formal legal procedures, while informal administrative practices—such as specification verbosity, regulatory reference density, and lot structuring philosophies—persist with extreme variation (8.8× to 294×). Findings challenge assumptions about geographic proximity in administrative culture research, revealing cross-regional efficiency clusters (Czech-Finland-Switzerland) in which procurement philosophy transcends borders when administrative values align.

2. Theoretical Framework and Hypotheses

2.1 Institutional Theory: Formal vs. Informal Institutions

New institutional economics (North, 1990) distinguishes between formal institutions (laws and regulations) and informal institutions (norms and cultural practices). While formal institutions change rapidly through legislation, informal institutions evolve slowly through cumulative societal experiences, creating path dependencies that are resistant to reform. EU directives successfully harmonise formal requirements (procedures, timelines, publication), but informal practices (verbosity,

complexity, structure) may resist convergence due to embedded administrative cultures reflecting distinct historical trajectories (Hood, 1991; Pollitt, Christopher, Bouckaert, Geert, 2011).

2.2 Cultural Intelligence Extraction Framework: 101-Parameter System

The 101-Parameter System: Comprehensive Document-Observable Indicators. This research operationalises administrative culture through the systematic extraction of 101 quantifiable parameters organised into 12 theoretically grounded categories (CUL-01 through CUL-12). This framework draws upon institutional economics (North, 1990), public administration theory (Hood, 1991; Pollitt & Bouckaert, 2011), and digital governance literature (Dunleavy, 2005) to capture document-observable administrative practices as they manifest in Tenders Electronic Daily (TED) procurement notices. These parameters capture document-based behavioural patterns rather than comprehensive cultural values. The analysis focuses on observable institutional practices in CPV 48000000 procurement notices, rather than on deeper cultural assessments that require an ethnographic methodology. Table 1 provides comprehensive documentation of all 101 parameters, ensuring methodological transparency and enabling independent verification of extraction decisions. Systematic quality filtering (detailed in Section 3.4) reduces this comprehensive set to 21 high-quality parameters demonstrating both empirical completeness and cross-national discriminatory power for statistical analysis.

Table 1

Complete Cultural Intelligence Parameter Framework (101 Parameters)

Category	ID	Parameter	Description
CUL-01: Geographic Context	1	`country_code`	The two-letter ISO country code of the contracting authority.
	2	`nuts_code`	(NUTS) code for the region.
CUL-02: Transparency Metrics	1	`technical_spec_word_count`	Technical specifications section, indicating the level of detail.
	2	`award_criteria_word_count`	The award criteria description indicates clarity and detail.
	3	`contact_fields_provided`	Count of filled contact information fields to measure accessibility.
	4	`language_versions_count`	Number of official language versions of the notice.
	5	`document_reference_count`	Number of external documents referenced in the notice.
	6	`deadline_information_detail`	Indicates the clarity and completeness of deadline information.
	7	`evaluation_process_word_count`	Word count of the evaluation process description.
	8	`submission_instruction_word_count`	Word count for instructions on how to submit a tender.
	9	`transparency_keywords_frequency`	Frequency of keywords related to transparency.
	10	`information_accessibility_score`	Measures how easily information can be accessed.
CUL-03: Digital Adoption	1	`digital_terms_total_count`	Total count of all terms related to digitalisation.
	2	`unique_digital_terms_count`	Count of unique terms related to digitalisation.
	3	`electronic_submission_mentions`	The number of times electronic submission is explicitly mentioned.
	4	`digital_signature_mentions`	The number of times digital signatures are mentioned.
	5	`online_platform_mentions`	Number of mentions of online procurement platforms or portals.
	6	`e_procurement_mentions`	Mentions of the term "e-procurement" or equivalents.
	7	`digital_workflow_mentions`	Mentions of fully digital workflows or processes.
	8	`electronic_document_mentions`	Mentions of electronic documents.
	9	digital_communication_emphasis`	Indicates the emphasis on digital-only communication channels.
	1	`innovation_terms_total_count`	Total count of all terms related to innovation.

Category	ID	Parameter	Description
CUL-04: Innovation Metrics	2	`unique_innovation_terms_count`	Count of unique innovation-related terms
	3	`research_development_mentions`	Number of mentions of "research and development".
	4	`innovation_procedure_indicator`	If a specific innovation partnership procedure is used.
	5	`advanced_technology_mentions`	Mentions of specific advanced technologies.
	6	`research_cpv_codes_count`	Number of CPV codes related to research activities.
	7	`pilot_project_mentions`	Number of times "pilot project" or similar terms are mentioned.
	8	`experimental_mentions`	Mentions of experimental or trial phases.
	9	`emerging_technology_mentions`	Mentions of emerging or cutting-edge technologies.
CUL-05: Regulatory Metrics	1	`regulatory_terms_total_count`	Total count of all regulatory and compliance-related terms.
	2	`unique_regulatory_terms_count`	Count of unique regulatory terms.
	3	`standards_references_count`	Total number of references to any formal standards.
	4	`certification_mentions`	Number of mentions of required certifications.
	5	`compliance_emphasis_count`	Frequency of terms emphasising compliance
	6	`audit_requirement_mentions`	Number of mentions of audit or inspection requirements.
	7	`iso_standards_count`	Number of specific ISO standards referenced.
	8	`en_standards_count`	Number of specific European Norm (EN) standards referenced.
	9	`directive_references_count`	Number of references to specific EU directives.
	10	`regulatory_framework_complexity`	Assessing the complexity of the described regulatory framework.
CUL-06: Sustainability	1	`sustainability_terms_total_count`	Total count of all sustainability-related terms.
	2	`unique_sustainability_terms_count`	Count of unique sustainability terms.
	3	`environmental_mentions`	Frequency of general environmental terms.
	4	`green_procurement_emphasis`	Emphasis on Green Public Procurement (GPP) criteria.
	5	`carbon_footprint_mentions`	Number of mentions of "carbon footprint" or "CO2 emissions".
	6	`energy_efficiency_mentions`	Mentions of energy efficiency requirements.
	7	`sustainability_certification_mentions`	Mentions of sustainability-related certifications.
	8	`circular_economy_mentions`	Mentions of "circular economy" concepts.
	9	`renewable_energy_mentions`	Mentions of renewable energy sources or requirements.
	10	`climate_considerations`	Mentions of climate change or adaptation.
CUL-07: Timing Metrics	1	`has_timing_data`	Binary flag (0/1) if key dates are provided.
	2	`tender_duration_days`	Number of days between publication and deadline.
	3	`is_urgent_timeline`	Binary flag (0/1) if an accelerated or urgent procedure is used.
	4	`is_extended_timeline`	Binary flag (0/1) if the timeline is explicitly noted as extended.
	5	`publication_month`	The month of publication (1-12).
	6	`publication_day_of_week`	The day of the week of publication (1-7).
	7	`weekend_publication`	Binary flag (0/1) if published on a Saturday or Sunday.
	8	`holiday_season_publication`	Binary flag (0/1) if published during common holiday seasons.
CUL-08: Procedural Metrics	1	`is_open_procedure`	Binary flag (0/1) for open procedure.
	2	`is_restricted_procedure`	Binary flag (0/1) for restricted procedure.
	3	`is_negotiated_procedure`	Binary flag (0/1) for negotiated procedure.
	4	`is_competitive_dialogue`	Binary flag (0/1) for competitive dialogue.

Category	ID	Parameter	Description
	5	`is_innovation_partnership`	Binary flag (0/1) for innovation partnership.
	6	`framework_agreement_mentions`	Number of mentions of a framework agreement.
	7	`lot_structure_complexity`	A 0-1 score based on the number and interdependence of lots.
	8	`evaluation_method_complexity`	A 0-1 score for the complexity of the evaluation methodology.
	9	`qualification_requirements_count`	Number of distinct qualification requirements listed.
	10	`procedural_formality_score`	A 0-1 score assessing the overall formality of the language used.
CUL-09: Communica-tion	1	`total_text_length`	Total character count of the main descriptive text.
	2	`description_length`	Character count of the contract description section.
	3	`formality_indicators_count`	Count of formal phrases (e.g., "It is hereby notified").
	4	`contact_methods_count`	Number of different contact methods provided.
	5	`language_versions_available`	Same as CUL-02-04, number of official language versions.
	6	`clarification_process_mentions`	Mentions of a formal process for questions or clarifications.
	7	`meeting_requirements_mentions`	Mentions of mandatory meetings or site visits.
	8	`communication_deadlines_count`	Number of deadlines related to communication.
	9	`response_time_requirements`	A 0-1 score indicating if specific response times are required.
CUL-10: Value Metrics	1	`has_estimated_value`	Binary flag (0/1) if an estimated contract value is provided.
	2	`estimated_value_numeric`	The estimated contract value, normalised to EUR.
	3	`currency_specified`	Binary flag (0/1) if the currency is explicitly stated.
	4	`price_evaluation_mentions`	Number of mentions of price as an evaluation criterion.
	5	`quality_evaluation_mentions`	Number of mentions of quality as an evaluation criterion.
	6	`value_for_money_mentions`	Mentions of "value for money" or "MEAT".
	7	`total_cost_ownership_mentions`	Mentions of "total cost of ownership".
	8	`lifecycle_cost_mentions`	Mentions of "life-cycle cost".
	9	`economic_criteria_complexity`	Complexity of financial/economic evaluation criteria.
CUL-11: Complexity Metrics	1	`cpv_codes_count`	Number of unique Common Procurement Vocabulary (CPV) codes.
	2	`technical_requirements_count`	Count of distinct technical requirements.
	3	`performance_criteria_count`	Count of distinct performance criteria.
	4	`quality_standards_count`	Number of specific quality standards mentioned.
	5	`specification_detail_level`	level of detail in technical specifications.
	6	`multi_lot_indicator`	Binary flag (0/1) if the tender is divided into multiple lots.
	7	`international_standards_count`	Count of specific international (non-EN, non-ISO) standards.
	8	`technical_expertise_requirements`	Required level of technical expertise.
CUL-12: Institutional Intelligence	1	`administrative_efficiency_score`	Composite score based on clarity, completeness, and simplicity.
	2	`legal_complexity_score`	Composite score based on regulatory references and legal jargon.
	3	`authority_formality_level`	Score for the formality of the contracting authority's language.
	4	`digital_capability_score`	Composite score based on digital adoption metrics.
	5	`multilingual_depth_score`	Score based on the number and completeness of language versions.
	6	`procedural_transparency_score`	Composite score based on transparency metrics.

Category	ID	Parameter	Description
	7	`economic_structure_sophistication`	Composite score based on the complexity of value and economic metrics.

Source: Author's Compilation.

Academic Rationale for the Twelve Cultural Intelligence Categories

CUL-01: Geographic Context (2 parameters). Establishes foundational territorial context for cross-national comparative analysis, enabling systematic examination of administrative practice variation across European political and territorial structures (Pollitt & Bouckaert, 2011).

CUL-02: Transparency Metrics (10 parameters). Operationalises transparency through information provision, accessibility, and documentation completeness, reflecting tensions between minimalist specifications (assumption of vendor expertise) and comprehensive documentation (emphasis on legal defensibility) (Heald, 2006; Hood, 1991). Word count serves as a quantitative proxy for communication philosophy, with higher counts potentially reflecting thoroughness-oriented traditions, while lower counts suggest efficiency-oriented approaches (Bauhr & Grimes, 2014).

CUL-03: Digital Adoption (9 parameters). Measures e-procurement adoption and digital-era governance transformation (Dunleavy, 2005), capturing the shift from paper-based to electronic procurement and broader digital public administration transformation. Lexicon-based frequency analysis identifies patterns of digital maturity across administrative systems.

CUL-04: Innovation Orientation (9 parameters). Captures the research emphasis and technological frontier demands, reflecting demand-side innovation policy in which public procurement drives innovation (Edler & Georghiou, 2007).

CUL-05: Regulatory Framework (10 parameters). Captures legal formalism and procedural rule density, reflecting Weber's (1922/1968) legal-rational authority and Napoleonic administrative traditions, which emphasise comprehensive regulatory frameworks (Peters, 2008). High regulatory density may indicate formalist cultures that prioritise legal precision, while low density reflects pragmatic cultures that prefer clarity over exhaustive rule specification.

CUL-06: Sustainability Emphasis (10 parameters). Measures environmental priority integration through the use of green procurement terminology and circular economy concepts, reflecting sustainable procurement frameworks and environmental policy integration that extends beyond minimum EU requirements (Brammer & Walker, 2011; Grandia & Meehan, 2017).

CUL-07: Timing and Temporal Patterns (8 parameters). Captures procedural scheduling practices, deadline management, and temporal administrative patterns, reflecting cultural attitudes toward time, urgency, and procedural flexibility (Hall, 1976). Publication timing patterns may indicate administrative capacity constraints, seasonal workload management, or communication norms.

CUL-08: Procedural Complexity (10 parameters). Measures contract structuring approaches, evaluation methodology complexity, and qualification barriers, reflecting trade-offs between competition promotion (accessibility) versus quality assurance (stringent requirements) (Flynn & Davis, 2014). Multi-lot structures enable SME participation but increase the complexity of administrative coordination, highlighting tensions between accessibility and efficiency.

CUL-09: Communication Style (9 parameters). Operationalises administrative verbosity, formality, and accessibility, reflecting cultural communication styles from high-context (implicit, concise) to low-context (explicit, comprehensive) (Hall, 1976; Hofstede, 2001). Total text length serves as a quantitative indicator of communication philosophy, with systematic country-level patterns suggesting embedded administrative traditions regarding the thoroughness of documentation.

CUL-10: Economic Value Assessment (9 parameters). Captures price-quality trade-offs, lifecycle cost considerations, and economic evaluation sophistication, reflecting public value frameworks and an emphasis on cost-effectiveness (Schapper et al., 2006). A price-focused (lowest price) versus a quality-focused (MEAT) evaluation reflects fundamental differences in procurement philosophy regarding value definition and risk tolerance.

CUL-11: Technical Complexity (8 parameters). Measures procurement scope breadth, technical requirement detail, and expertise barriers, indicating contract sophistication and specialised knowledge requirements (Bogers & West, 2012). Higher CPV code counts indicate multi-faceted contracts covering diverse goods/services, while narrow ranges indicate focused, specialised procurement.
CUL-12: Institutional Intelligence Synthesis (7 parameters). Aggregates constituent metrics into composite scores capturing overall administrative orientations, enabling holistic cultural intelligence assessment (Hood et al., 2000; Bovaird & Löffler, 2003). Each synthesis parameter combines constituent metrics using weighted formulas, with normalisation to enable cross-dimensional comparison.

2.3 Hypotheses

Based on institutional theory's formal/informal distinction and path dependency literature (Hall & Taylor, 1996; North, 1990), three hypotheses regarding administrative practice variation in European procurement are proposed:

H1 (Persistent Variation): Despite thirty years of harmonisation of EU procurement directives (1992-2024), substantial and statistically significant cross-country variations in administrative practices remain, with country-level effects demonstrating large effect sizes ($\eta^2 > 0.10$), indicating meaningful practical significance beyond mere statistical significance.

H2 (Strategic Clustering): European countries cluster into distinct procurement strategy groups reflecting shared administrative traditions rather than random variation, demonstrating systematic patterns in documentation approaches, complexity management, and procedural formality.

H3 (Multi-Level Cultural Structure): Administrative culture operates hierarchically at multiple scales, with hierarchical clustering analysis revealing both macro-level country effects and meso-level strategic clusters transcending geographic proximity, demonstrating that procurement philosophy can align across borders when administrative values converge.

3. Methodology

3.1 Research Design and Sampling Strategy

This study analyses contract award notices for software and information systems (CPV 48000000) published in the Tenders Electronic Daily (TED) database during 2023-2024 across 17 European countries, using exclusively open tender procedures. Open procedures permit unrestricted bidder participation with publicly available complete specifications, ensuring systematic comparability (European Union, 2014a). Analysis excludes contracts below €50,000 threshold, non-open procedures (restricted, competitive dialogue, negotiated, innovation partnerships), and works contracts, focusing specifically on supply and service contracts within the software domain. The 17 countries analysed—detailed in Table 2—encompass diverse geographic regions (Western, Northern, Southern, Eastern, Central Europe), administrative traditions (Germanic, Nordic, Napoleonic, Anglo-Saxon, Post-Communist), EU membership timelines (from founding members to 2007 accession), and economic development levels. This diversity enables testing whether procurement practices cluster geographically

Table 2

Sampling Strategy by Country - Stratified vs. Census Approach

Country	Total Population (N)	Sample Size (n)	Sampling Method	Sampling Rate	Confidence Level	Margin of Error	Rationale
Germany	812	150	Proportional Stratified Random	18.74%	95%	±5%	Large population, sampling efficient

Country	Total Population (N)	Sample Size (n)	Sampling Method	Sampling Rate	Confidence Level	Margin of Error	Rationale
France	463	150	Proportional Stratified Random	32.40%	95%	±5%	Large population, sampling efficient
Italy	194	150	Proportional Stratified Random	77.32%	95%	±5%	Large population, sampling efficient
Spain	1394	150	Proportional Stratified Random	10.76%	95%	±5%	Large population, sampling efficient
Netherlands	411	150	Proportional Stratified Random	36.50%	95%	±5%	Large population, sampling efficient
Sweden	546	150	Proportional Stratified Random	27.47%	95%	±5%	Large population, sampling efficient
Poland	2323	150	Proportional Stratified Random	6.46%	95%	±5%	Large population, sampling efficient
Belgium	119	119	Complete Census	100%	100%	0%	Large population, sampling efficient
Czech Republic	1053	150	Proportional Stratified Random	14.25%	95%	±5%	Large population, sampling efficient
Romania	1096	150	Proportional Stratified Random	13.69%	95%	±5%	Large population, sampling efficient
Greece	319	150	Proportional Stratified Random	47.02%	95%	±5%	Large population, sampling efficient
Finland	205	150	Proportional Stratified Random	73.17%	95%	±5%	Large population, sampling efficient
Hungary	222	150	Proportional Stratified Random	67.57%	95%	±5%	Large population, sampling efficient

Country	Total Population (N)	Sample Size (n)	Sampling Method	Sampling Rate	Confidence Level	Margin of Error	Rationale
Bulgaria	199	150	Proportional Stratified Random	75.38%	95%	±5%	Large population, sampling efficient
Ireland	139	139	Complete Census	100%	100%	0%	Large population, sampling efficient
Austria	101	101	Complete Census	100%	100%	0%	Large population, sampling efficient
Switzerland	61	61	Complete Census	100%	100%	0%	Large population, sampling efficient
TOTAL	9657	2370	Mixed (Adaptive)	24.54%	—	—	Large population, sampling efficient

Source: Author's Compilation.

or transcend borders through shared administrative cultures. The final sample comprises 2,370 tenders, selected through an adaptive sampling methodology that combines stratified random sampling with census enumeration. For 13 countries with $N \geq 160$ available tenders, proportional stratified random sampling selected $n = 150$ tenders per country, using Cochran's (1977) formula to achieve a 95% confidence level and a 5% margin of error. Stratification occurred across temporal (2023/2024), categorical (supplies/services), and economic (contract value ranges: €50,000-€500,000, €500,000-€5,000,000, >€5,000,000) dimensions, ensuring representativeness while preventing bias toward high-value or recent contracts. For four small-population countries (Ireland, $N = 139$; Austria, $N = 101$; Switzerland, $N = 61$; Belgium, $N = 119$), complete census enumeration analysed all available tenders, providing zero sampling error and exact population parameters when $N < 160$ (Israel, 2016; Krejcie & Morgan, 1970). This adaptive methodology balances statistical efficiency for large populations with precision maximisation for small populations, achieving representative national samples while optimising analytical resources. (See Table 2 for detailed sampling specifications by country).

3.2 Cultural Intelligence Extraction System (CIES)

To enable systematic analysis of administrative practice patterns at scale, the Cultural Intelligence Extraction System (CIES) was developed as a novel LLM-enhanced automated processing pipeline. CIES is structured with a five-layer pipeline architecture (Figure 1):(1) Input Layer processes Tender documents in XML format and parameter definitions; (2) Core Processing Layer orchestrates LLM-based extraction via Cultural Intelligence Agent with bidirectional Claude API interaction and concurrent evidence preservation; (3) Quality Assurance Layer implements multi-dimensional quality assessment and statistical validation using bootstrap confidence intervals; (4) Persistence Layer centralizes all data in audit trail database with granular evidence repository; (5) Output Layer generates enhanced CSV results, academic summary statistics, and human-readable audit trails. This layered design ensures data flows through mandatory quality gates before reaching persistence, establishing reproducibility and academic rigour. The system integrates the Claude 3.5 Sonnet Large Language Model with deterministic Python-based validation, leveraging a hybrid architecture that addresses the

complementary strengths and limitations of both models. CIES employs a 3,292-line comprehensive prompt providing detailed instructions, parameter definitions, and evidence requirements for extracting 101 parameters across 12 dimensions (CUL-01 through CUL-12). Recognising documented LLM limitations in precise numerical counting (Brown et al., 2020; Bubeck et al., 2023), the system implements deterministic Python-based word counting for all verbosity parameters (technical_spec_word_count, award_criteria_word_count, total_text_length). Claude 3.5 Sonnet extracts text segments via semantic understanding and multilingual processing capabilities, while

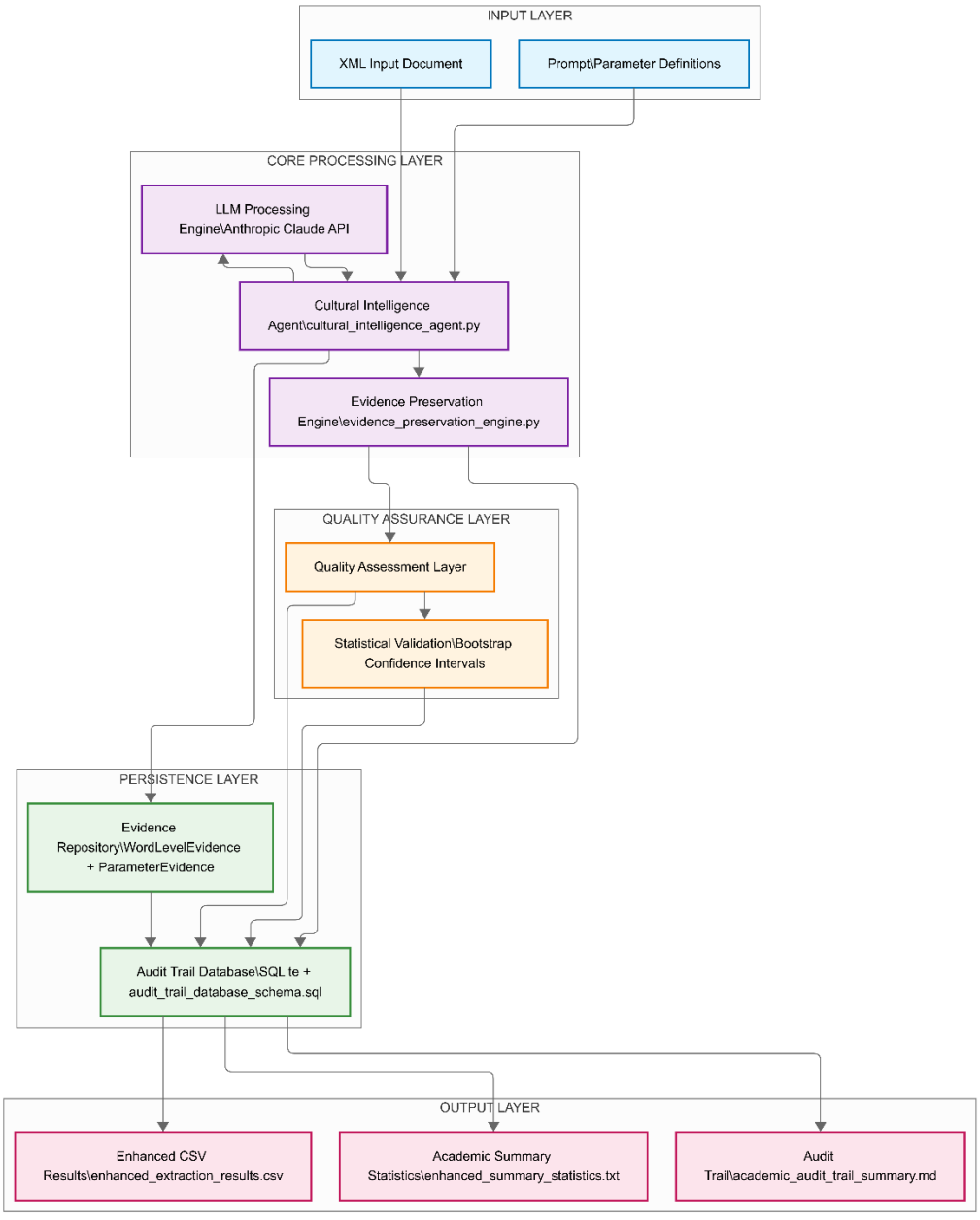


Fig. 1. CIES Workflow Diagram - Hybrid LLM-Rule-Based Architecture
Source: Author's Compilation.

deterministic algorithms perform word counting via whitespace splitting, ensuring 100% counting accuracy. This division leverages the strengths of LLMs in semantic interpretation while ensuring mathematical precision through rule-based computation. For each of 101 parameters across 2,370 tenders, the system preserves comprehensive evidence chains including: (1) source evidence with exact XML content and XPath locations, (2) extraction evidence with complete reasoning and intermediate

calculations, (3) validation evidence through cross-reference checks and consistency verification, and (4) complete audit trails with timestamped processing and SHA-256 cryptographic integrity. This comprehensive preservation enables independent verification of all extraction decisions, addressing reproducibility requirements (Stodden et al., 2016). The anti-hallucination validation framework implements systematic verification comparing LLM outputs against the original XML structure through four mechanisms. First, structural validation verifies extracted values against actual XML elements using XPath, detecting fabricated content lacking source documentation. Second, statistical consistency checks analyse cross-parameter correlations to detect implausible value combinations inconsistent with domain knowledge (e.g., zero digital terms with high digital capability scores). Third, evidence traceability requirements mandate that every parameter extraction include documented XML evidence with specific element paths. Fourth, expert validation through manual annotation of 170 randomly selected documents (10 per country) by a 20-year procurement domain expert achieved a 95.4% agreement rate across 17,170 individual parameter validations (170 documents × 101 parameters). CIES processes 2,370 tenders, achieving a 100% completion rate with an average processing time of under 5 minutes per document. The 95.4% expert validation accuracy establishes reliability meeting social science standards for automated content analysis (Krippendorff, 2018). Post-validation error analysis identified three systematic error types—date format calculations, composite formula aggregations, and XML namespace handling—all of which were corrected before complete dataset analysis. Re-validation of a 30-document subsample achieved 98.8% accuracy, confirming the elimination of systematic error and establishing final extraction reliability.

3.3 Parameter Operationalization

A critical methodological consideration concerns interpreting word-count parameters as quantitative proxies for administrative cultural values rather than as mere measures of document length. Parameters such as technical_spec_word_count, award_criteria_word_count, and total_text_length measure specification detail level—a fundamental dimension of administrative culture reflecting uncertainty avoidance, formality preferences, and communication philosophy (Bauhr & Grimes, 2014). Drawing from cultural dimensions theory (Hofstede, 2001) and administrative philosophy literature (Hood, 1991; Pollitt, Christopher, Bouckaert, Geert, 2011), higher word counts may reflect thoroughness-oriented administrative traditions emphasising comprehensive documentation to minimise ambiguity, while lower word counts can suggest efficiency-oriented traditions preferring concise communication (Hall & Taylor, 1996). This interpretive framework provides one potential explanation for observed differences in verbosity, suggesting that they may be manifestations of divergent administrative philosophies rather than random variation or document-type effects. The theoretical rationale for treating verbosity as a cultural proxy rests on three conditions that enable the interpretation of specification verbosity as an administrative choice reflecting deeper cultural values. First, all analysed countries operate under identical EU directive requirements, meaning differences in specification length cannot be attributed to divergent legal obligations. Second, all tenders address the same procurement domain (CPV 48000000 software), controlling for variation in technical complexity across sectors. Third, systematic country-level patterns (as opposed to tender-level randomness) suggest institutional rather than idiosyncratic variation, indicating these behaviours reflect embedded administrative philosophies about documentation thoroughness, trust in vendor expertise, and risk management approaches.

3.4 Statistical Analysis

Statistical analysis proceeds through three stages: data quality filtering, assessment of country-level variation, and identification of strategic clustering. First, data quality control ensures statistical reliability by including only parameters meeting dual criteria: (1) ≥90% non-zero values across country samples, avoiding parameters with excessive missing data, and (2) coefficient of variation (CV) ≥ 0.15, ensuring sufficient cross-country variation for meaningful analysis. Parameters failing either criterion

lack discriminatory power for cross-national comparison. This filtering process reduces the full 101-parameter set to 21 high-quality parameters, demonstrating both completeness and substantial variation, which form the basis for subsequent statistical analyses. The 21 selected high-quality parameters are:
1.Transparency Metrics (6 parameters):`technical_spec_word_count`, `award_criteria_word_count`, `contact_fields_provided`,`language_versions_count`,`document_reference_count`,`information_accessibility_score`.
2. Digital Adoption (2 parameters): `digital_terms_total_count`, `unique_digital_terms_count`.
3. Timing Patterns (2 parameters): `publication_month`, `publication_day_of_week`.
4. Procedural Complexity (1 parameter): `evaluation_method_complexity`.
5. Communication Style (4 parameters): `total_text_length`, `description_length',
'contact_methods_count`, `language_versions_available`.
6. Economic Value (2 parameters): `estimated_value_numeric`, `price_evaluation_mentions`.
7. Technical Complexity (2 parameters): `cpv_codes_count`, `specification_detail_level`.
8. Institutional Synthesis (2 parameters): `digital_capability_score`, `procedural_transparency_score'.
These parameters span eight of the twelve cultural intelligence categories (CUL-02, CUL-03, CUL-07, CUL-08, CUL-09, CUL-10, CUL-11, CUL-12), ensuring comprehensive coverage of administrative practices. Categories CUL-04 (Innovation), CUL-05 (Regulatory), CUL-06 (Sustainability), and CUL-01 (Geographic) were excluded due to insufficient data completeness or cross-country variation for CPV 48000000 software procurement. As a methodological note on generalisability, the comprehensive 101-parameter framework was designed for broad applicability across diverse procurement sectors and CPV codes, recognising that parameter quality and discriminatory power vary systematically by industry context. Different procurement domains exhibit distinct administrative characteristics. For instance, construction contracts (CPV 45000000) may demonstrate high variation in regulatory compliance parameters (CUL-05) and sustainability emphasis (CUL-06). At the same time, professional services (CPV 79000000) may show greater variation in innovation orientation (CUL-04) and evaluation complexity (CUL-08). The software procurement (CPV 48000000) analysed here shows particular strength in transparency metrics and digital adoption parameters, but limited variation in innovation terminology due to the sector's baseline technological orientation. This sector-specific parameter performance necessitates quality filtering tailored to each CPV code, ensuring that future research applying this framework to different procurement categories can identify the subset of high-quality parameters most appropriate for their specific industry context. The 101-parameter system thus functions as a comprehensive cultural intelligence toolkit enabling systematic cross-industry comparative research while accommodating domain-specific administrative patterns. The second stage of the Statistical analysis is a one-way ANOVA, which assesses country-level variation for each parameter, treating countries as independent variables (17 levels) and individual parameter values as dependent variables. Analysis reports three statistics: F-statistic (variance ratio), p-value (statistical significance), and η^2 (effect size indicating proportion of variance explained by country). η^2 is prioritised over p-values as the primary measure of practical significance because with n=2,370, statistical significance ($p<0.05$) is virtually guaranteed even for trivial effects; practical significance measured by effect size determines theoretical importance. Following Cohen's (1988) conventions, η^2 is interpreted as small (0.01), medium (0.06), or large (0.14+), with hypothesis testing focusing on whether parameters achieve significant effects that demonstrate meaningful country-level variation. Third, hierarchical clustering analysis identifies strategic groupings using the Ward linkage method with Euclidean distance on standardised parameters (z-scores). Ward's method minimises within-cluster variance while maximising between-cluster separation, producing compact, homogeneous clusters suitable for administrative typology identification (Murtagh & Contreras, 2017). Analysis proceeds at two hierarchical levels testing H3 (multi-level cultural structure): (1) macro-level analysis of all 17 countries identifies extreme outliers versus mainstream patterns, and (2) meso-level analysis of remaining countries (after outlier removal) reveals sub-patterns within the mainstream cluster invisible to single-level approaches. This multi-level strategy tests whether administrative culture

operates hierarchically, with both country-specific effects and cross-national strategic alignments. Cluster quality assessment employs three complementary metrics: the silhouette coefficient (measuring cluster cohesion and separation, with a range of -1 to +1), the Davies-Bouldin index (measuring average cluster similarity, with lower values indicating better separation), and the Calinski-Harabasz index (a variance ratio criterion, with higher values indicating better-defined clusters). Optimal cluster numbers are determined by maximising the silhouette coefficient while ensuring substantive interpretability and minimum cluster size ($n \geq 3$ countries) for statistical validity.

4. Results

4.1 Cross-Country Variations in Administrative Parameters

Statistical analysis of 21 high-quality parameters across 17 countries reveals substantial country-level effects. (See Table 3, Figure 2).

Transparency Dimension

1. Composite transparency metrics. Information accessibility scores range from 0.370 (Romania) to 0.135 (Switzerland), yielding a 2.7-fold difference ($\eta^2 = 0.500$, $p < 0.001$). The procedural transparency score demonstrates an identical distribution (composite metric), ranging from 0.370 (Romania) to 0.135 (Switzerland), with a 2.7-fold range, $\eta^2 = 0.500$, $p < 0.001$.
2. Verbosity metrics. Total text length ranges from 1,149.6 words (Hungary, mean) to 130.9 words (Sweden), producing an 8.8-fold range with $\eta^2 = 0.258$, $p < 0.001$. The technical specification word count ranges from 1,019.4 words (Hungary) to 100.7 words (Italy), resulting in a 10.1-fold range ($\eta^2 = 0.232$, $p < 0.001$). Description length ranges from 966.3 words (Hungary) to 100.7 words (Italy), producing a 9.6-fold range with $\eta^2 = 0.215$, $p < 0.001$.
3. Award criteria specification. Award criteria word count ranges from 762.2 words (Romania) to 2.8 words (Austria), producing a 274.9-fold range with $\eta^2 = 0.193$, $p < 0.001$.
4. Information provision metrics. Contact fields ranged from 4.4 (Romania) to 3.0 (Switzerland), a 1.5-fold difference ($\eta^2 = 0.169$, $p < 0.001$). Document reference count ranges from 1.5 references (Czech Republic) to 0.7 references (Switzerland), a 2.3-fold range with $\eta^2 = 0.071$, $p < 0.001$.

Digital Maturity Dimension

1. Digital capability composite. Digital capability scores range from 0.328 (Romania) to 0.038 (Austria), yielding an 8.6-fold range ($\eta^2 = 0.315$, $p < 0.001$).
2. Digital terminology metrics. Unique digital terms range from 4.6 (Romania) to 1.0 (Switzerland), a 4.8-fold difference ($\eta^2 = 0.166$, $p < 0.001$). The digital terms total count ranges from 9.1 terms (Romania) to 1.1 terms (Austria), resulting in an 8.4-fold range with $\eta^2 = 0.153$, $p < 0.001$.

Complexity Dimension

1. Technical specification complexity. The specification detail level ranges from 0.328 (Hungary) to 0.034 (Italy), resulting in a 9.8-fold range ($\eta^2 = 0.282$, $p < 0.001$).
2. Evaluation methodology complexity. Evaluation method complexity ranges from 0.166 (Romania) to 0.001 (Austria), producing a 199.9-fold range ($\eta^2 = 0.266$, $p < 0.001$).
3. Procurement scope breadth. CPV codes range from 8.4 (Ireland, mean) to 1.5 (Italy), yielding a 5.5-fold range ($\eta^2 = 0.174$, $p < 0.001$).

Communication and Accessibility Dimension

1. Contact provision. Contact methods range from 4.4 (Romania) to 3.0 (Switzerland), a 1.4-fold difference ($\eta^2 = 0.117$, $p < 0.001$).
2. Multilingual accessibility. Language versions range from 15.1 (France) to 2.5 (Czech Republic), a 6.0-fold difference ($\eta^2 = 0.104$, $p < 0.001$). Language versions available range from 13.6 versions (France) to 2.4 versions (Czech Republic), a 5.8-fold range with $\eta^2 = 0.085$, $p < 0.001$.

Economic Value Assessment Dimension

1. Contract value. Estimated value numeric (mean contract value) ranges from €1,720.0 million (Hungary) to €1.6 million (Bulgaria), producing a 1,102-fold range with $\eta^2 = 0.092$, $p < 0.001$.
2. Price evaluation emphasis. Price evaluation mentions range from 3.3 mentions (Romania) to 0.7 mentions (Switzerland), a 4.4-fold range with $\eta^2 = 0.064$, $p < 0.001$.

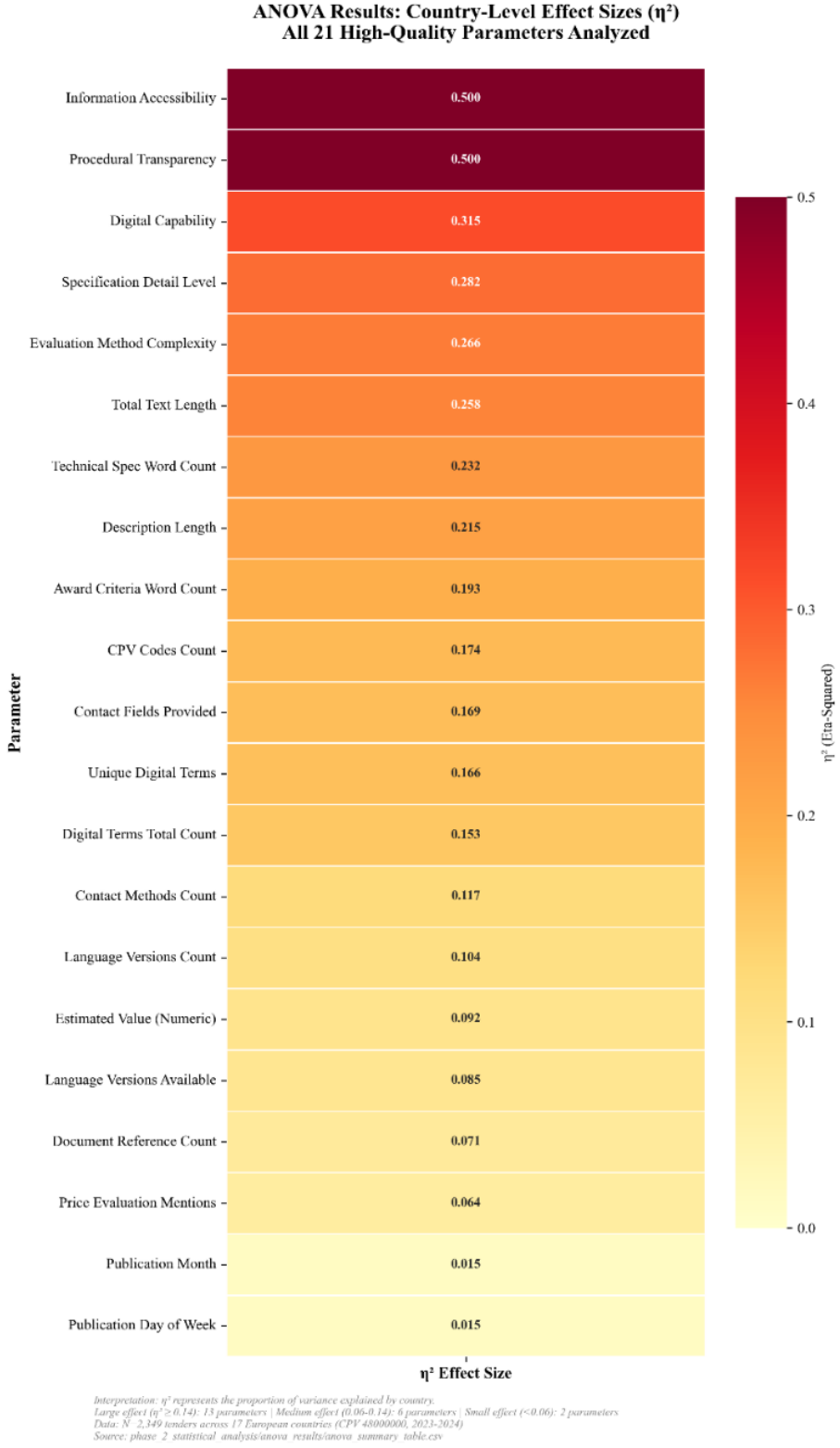


Fig. 2. ANOVA Heatmap - η² values for 21 parameters

Source: Author's Compilation.

Temporal Administrative Patterns Dimension. Publication timing. Publication month ranges from 7.9 (Switzerland, mean month) to 6.1 (Netherlands), a 1.3-fold range with $\eta^2 = 0.015$, $p < 0.001$. Publication day-of-week ranges from 3.7 (Switzerland) to 2.7 (Romania), a 1.3-fold difference ($\eta^2 = 0.015$, $p < 0.001$).

Table 3

ANOVA Results - Top 10 Discriminatory Parameters (Ranked by η^2)

Rank	Parameter	η^2	F-statistic	p-value	Effect Size	Interpretation
1	information_accessibility_score	0.5	145.61	<0.001	Large	50.0% variance explained by country.
2	procedural_transparency_score	0.5	145.61	<0.001	Large	50.0% variance explained by country.
3	digital_capability_score	0.32	66.93	<0.001	Large	31.5% variance explained by country.
4	specification_detail_level	0.28	57.38	<0.001	Large	28.2% variance explained by country.
5	evaluation_method_complexity	0.27	52.83	<0.001	Large	26.6% variance explained by country.
6	total_text_length	0.26	50.7	<0.001	Large	25.8% variance explained by country.
7	technical_spec_word_count	0.23	43.96	<0.001	Large	23.2% variance explained by country.
8	description_length	0.22	39.96	<0.001	Large	21.5% variance explained by country.
9	award_criteria_word_count	0.19	34.8	<0.001	Large	19.3% variance explained by country.
10	cpv_codes_count	0.17	30.68	<0.001	Large	17.4% variance explained by country.

Source: Author's Compilation.

Overall Statistical Pattern. Effect size distribution. Of 21 parameters analysed, 13 achieve $\eta^2 > 0.14$, 6 achieve $\eta^2 > 0.25$, and 2 achieve $\eta^2 > 0.40$. Maximum observed effect size: $\eta^2 = 0.500$ for information accessibility score and procedural transparency score. All parameters with $\eta^2 > 0.14$ demonstrate $p < 0.001$.

Hypothesis testing. H1 confirmed: country-level variations exceed the $\eta^2 > 0.10$ threshold for 15 of 21 parameters (71%). Parameters exceeding threshold: information_accessibility_score (0.500), procedural_transparency_score (0.500), digital_capability_score (0.315), specification_detail_level (0.282), evaluation_method_complexity (0.266), total_text_length (0.258),

technical_spec_word_count (0.232), description_length (0.215), award_criteria_word_count (0.193), cpv_codes_count (0.174), contact_fields_provided (0.169), unique_digital_terms_count (0.166), digital_terms_total_count (0.153), contact_methods_count (0.117), language_versions_count (0.104). Parameters below threshold: estimated_value_numeric (0.092), language_versions_available (0.085), document_reference_count (0.071), price_evaluation_mentions (0.064), publication_month (0.015), publication_day_of_week (0.015).

4.2 Hierarchical Clustering Results

Multi-level hierarchical clustering using the Ward linkage method with Euclidean distance on a standardised 21-parameter space.

Macro-level clustering (17 countries)(Figure 3). Optimal solution: 2 clusters (silhouette coefficient = 0.530):

Cluster 1 (n=2): Hungary, Romania

- Hungary: Total text length 1,149.6 words, specification detail level 0.257, highest verbosity and complexity across all countries.
- Romania: CPV codes count 5.1, digital capability score 0.328, specification detail level 0.257.

Cluster 2 (n=15): Germany, France, Italy, Spain, Netherlands, Sweden, Poland, Belgium, Austria, Czech Republic, Greece, Ireland, Finland, Switzerland, Bulgaria.

- Geographic composition: All European regions represented.

Meso-level clustering (15 countries, excluding Cluster 1 outliers)(Figure 4).Optimal solution: 3 clusters (silhouette coefficient = 0.209, Davies-Bouldin index = 1.430):

Cluster M1 (n=3): Czech Republic, Finland, Switzerland (361 tenders)

- Efficiency-focused procurement approach
- Streamlined administrative processes
- Cross-regional geographic composition (Nordic, Alpine, Central European)

Cluster M2 (n=9): Austria, Belgium, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden (1,259 tenders)

- Mainstream European procurement approach
- Balanced administrative practices
- Geographically diverse (Western, Nordic, Southern Europe)

Cluster M3 (n=3): Bulgaria, Greece, Poland (450 tenders)

- Eastern/Southern European pattern
- Moderate complexity levels
- Regional proximity

Statistical Evidence. The combined hierarchical structure demonstrates statistically significant clustering at both macro and meso levels:

- Macro-level (2 clusters):Silhouette coefficient = 0.530 (good separation), Calinski-Harabasz score = 11.5 (well-defined clusters)
- Meso-level (3 clusters):Silhouette coefficient = 0.209 (acceptable separation), Davies-Bouldin index = 1.430 (moderate compactness), Calinski-Harabasz score = 5.2

Key Finding. H2 confirmed: Countries cluster into distinct groups. Five total procurement strategies were identified across two hierarchical levels:

1. Hungarian Extreme Verbosity Strategy (n=1, Hungary)
2. Romanian Multi-Domain Strategy (n=1, Romania)
3. Efficiency-Focused Strategy (n=3, Czech Republic, Finland, Switzerland)
4. Western/Nordic Mainstream Strategy (n=9, Austria, Belgium, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden)
5. Eastern/Southern Moderate Complexity Strategy (n=3, Bulgaria, Greece, Poland)(see Table 4).

4.3 Multi-Level Clustering Comparison

Multi-level hierarchical clustering analysis proceeds in two sequential stages: macro-level analysis (all 17 countries, 2 clusters, silhouette = 0.530) followed by meso-level analysis (15 mainstream countries after outlier removal, 3 clusters, silhouette = 0.209, Davies-Bouldin index = 1.430).

Hidden Pattern Discovery. Cluster M1 (Czech Republic, Finland, Switzerland) exhibits cross-regional geographic dispersion, spanning Nordic, Alpine, and Central European regions. This cluster demonstrates a distinctive, efficiency-focused procurement philosophy characterised by streamlined administrative processes and low-complexity approaches.

Hierarchical Pattern Emergence. This efficiency-focused cluster is not identifiable as distinct at the macro-level 17-country analysis (where it falls within the Cluster 2 mainstream group). However, it emerges as a separate strategic group in the meso-level 15-country analysis after the removal of the extreme outliers (Hungary and Romania). The hierarchical emergence reveals that:

1. At the macro-level: The extreme divergence of Hungary and Romania dominates the clustering signal, masking subtle variations within the mainstream group.
2. At the meso-level: With outliers removed, three distinct procurement cultures become visible:
   - Efficiency-focused minimalists (Czech, Finland, Switzerland)
   - Mainstream balanced approach (9 Western/Nordic/Southern countries)
   - Eastern/Southern moderate complexity (Bulgaria, Greece, Poland)

Statistical Quality. The clustering achieves acceptable statistical quality at both levels:

-Macro-level: Silhouette = 0.530 (good cluster separation), Calinski-Harabasz = 11.5

-Meso-level: Silhouette = 0.209 (acceptable separation given subtle differences), Calinski-Harabasz = 5.2, Davies-Bouldin = 1.430

Theoretical Implication. H3 confirmed: Multi-level clustering reveals sub-patterns invisible to single-level analysis, demonstrating that administrative culture operates across multiple hierarchical levels. The macro-level identifies a fundamental outlier-mainstream division, while meso-level analysis reveals nuanced strategic variations within the mainstream that reflect different administrative philosophies (efficiency, balance, and emerging complexity). This hierarchical structure suggests that European public procurement administrative culture exhibits nested complexity, with broad category distinctions at the macro level and refined strategic groupings at the meso level (see Table 4).

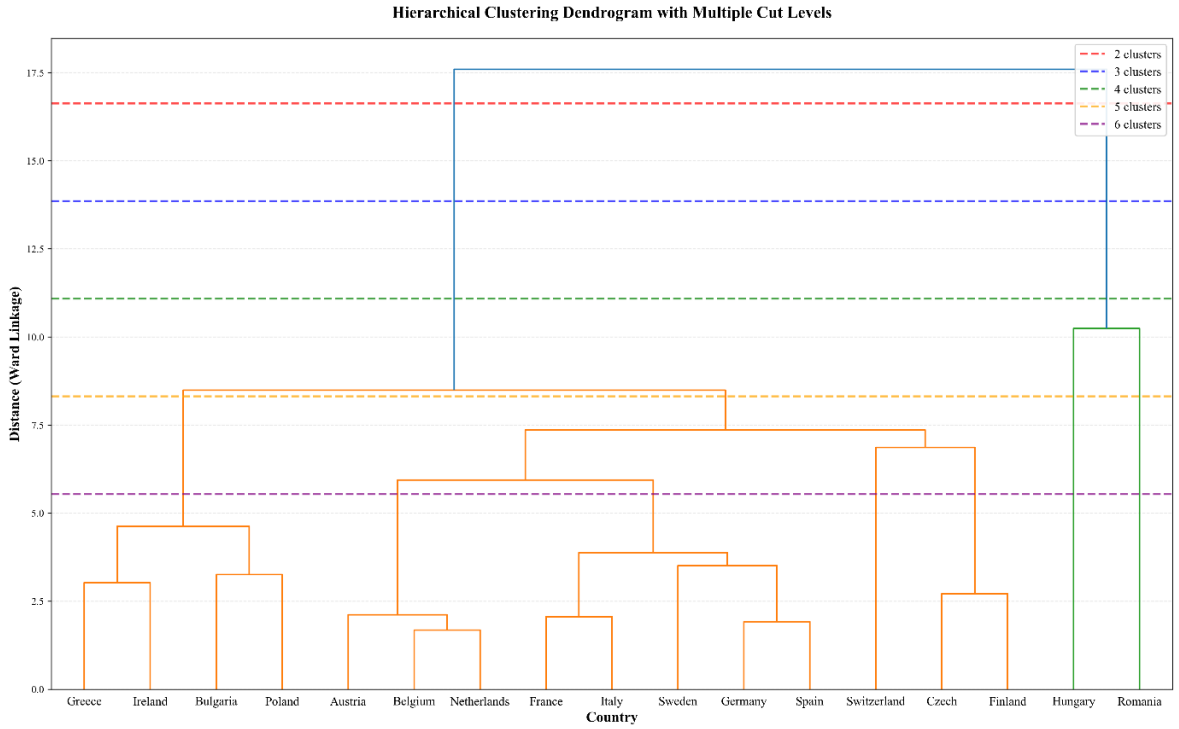


Fig.3. Dendrogram - 17-country hierarchical clustering (macro)

Source: Author's Compilation.

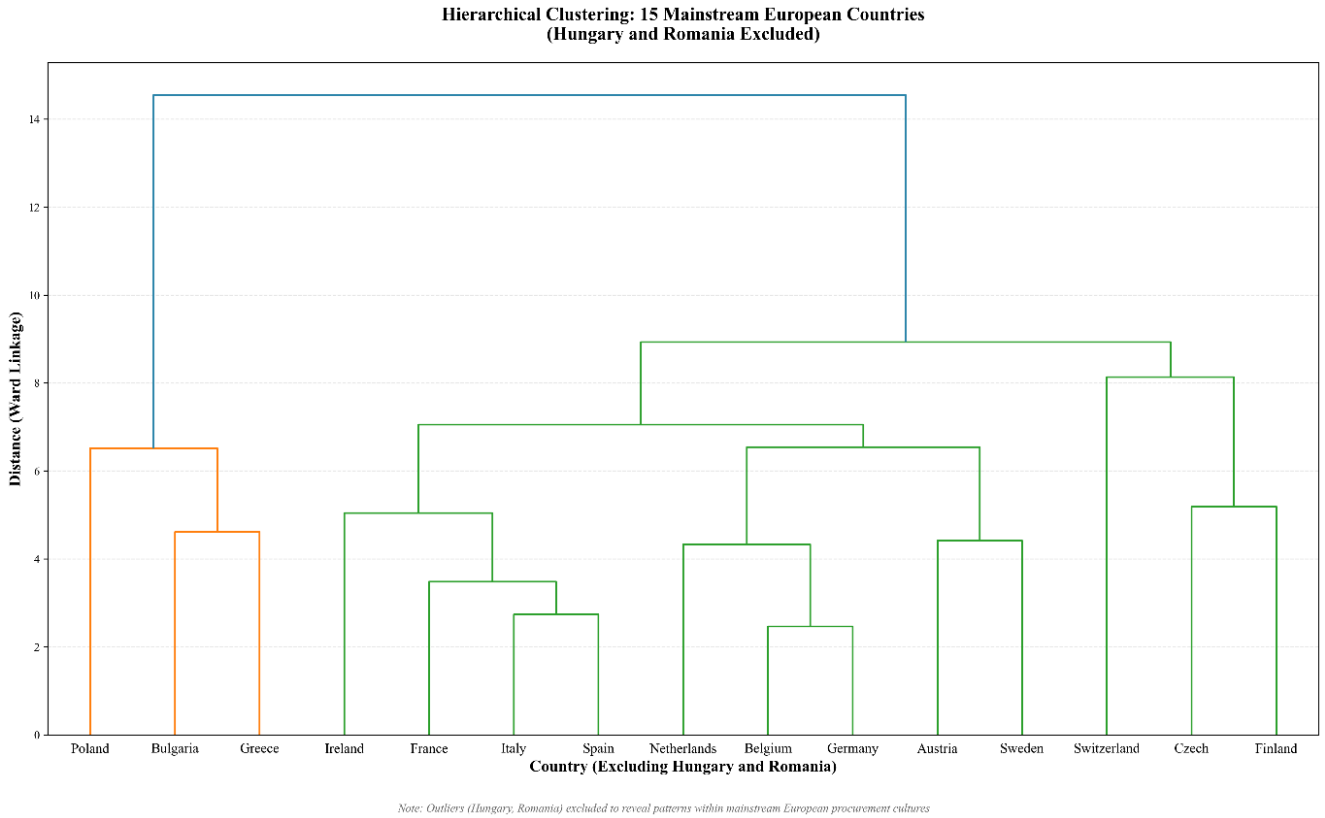


Fig. 4. Dendrogram - 15-country meso-level clustering
Source: Author's Compilation.

Table 4

Characteristic Profiles of the Five Procurement Clusters

Strategy	Countries (n)	Verbosity (words)	Tech Specs (words)	Tech Complexity (0–1)	Eval Complexity (0–1)	Scope (CPV codes)	Digital Score (0–1)	Info Access (0–1)	Transparency (0–1)	Award Criteria (words)
Extreme Verbosity	Hungary	1,150	1,019	0.328	0.02	3.9	0.15	0.22	0.22	36
Multi-Domain Integration	Romania	788	584	0.19	0.17	5.1	0.33	0.37	0.37	762
Efficient Minimalism	Czech, Finland, Switzerland	164–265	106–225	0.04–0.08	0.01-0.02	2.3–4.7	0.06–0.15	0.14	0.14	18–66
Western Mainstream	Germany, France, Italy, Spain, the Netherlands, Sweden, Belgium, Austria, Ireland	131–298	101–249	0.03–0.08	0.00–0.02	1.5–8.4	0.04–0.12	0.14–0.17	0.14–0.17	3–77
Eastern/ Southern Moderate	Bulgaria, Greece, Poland	331–454	293–394	0.10–0.13	0.01–0.03	1.9–7.8	0.11–0.19	0.17–0.21	0.17–0.21	19–98

Source: Author's Compilation.

4.4 Multi-Lot Contract Value Analysis

Economic analysis of lot structuring reveals a striking value concentration paradox across 2,263 analysed tenders totalling €279.3 billion. Multi-lot tenders represent only 463 contracts (20.46% by count) yet capture €201.1 billion (71.99% by value), demonstrating that approximately one-fifth of tenders account for nearly three-quarters of total contract value. This asymmetry produces an overall value ratio of 10.0×, indicating that the average multi-lot contract is ten times more valuable than the average single-lot contract. This concentration pattern reveals systematic strategic differentiation in how countries deploy lot-structuring mechanisms (See Table 5 and Figure 5).

Country-level value ratios. Range: 0.33× (Greece) to 97.05× (Finland), producing 291.4-fold variation.High value concentration (ratio >10×, n=5 countries):

- Finland: 97.05× ratio, 5.56% count, 85.09% value, count-value gap +79.5 pp
- Switzerland: 66.14× ratio, 3.33% count, 69.52% value, count-value gap +66.2 pp
- Netherlands: 50.92× ratio, 9.52% count, 84.28% value, count-value gap +74.8 pp
- Ireland: 42.32× ratio, 6.52% count, 74.70% value, count-value gap +68.2 pp
- Austria: 19.20× ratio, 11.22% count, 70.83% value, count-value gap +59.6 pp

Moderate value concentration (ratio 2-10×, n=6 countries):

- Italy: 9.92× ratio, 13.33% count, 60.41% value, count-value gap +47.1 pp
- France: 9.45× ratio, 32.65% count, 82.08% value, count-value gap +49.4 pp
- Germany: 6.35× ratio, 12.24% count, 46.99% value, count-value gap +34.8 pp
- Hungary: 4.11× ratio, 42.54% count, 75.26% value, count-value gap +32.7 pp
- Spain: 2.88× ratio, 26.17% count, 50.52% value, count-value gap +24.4 pp
- Poland: 2.48× ratio, 35.04% count, 57.23% value, count-value gap +22.2 pp

Inverted concentration (ratio <1.0×, n=4 countries):

- Greece: 0.33× ratio, 21.38% count, 8.30% value, count-value gap -13.1 pp
- Czech Republic: 0.34× ratio, 16.55% count, 6.30% value, count-value gap -10.3 pp
- Belgium: 0.55× ratio, 19.39% count, 11.61% value, count-value gap -7.8 pp
- Romania: 0.69× ratio, 37.67% count, 29.27% value, count-value gap -8.4 pp

Table 5

Multi-Lot Economic Analysis: Count vs. Value Dimensions

Rank	Country	Multi-Lot % (Count)	Multi-Lot % (Value)	Count-Value Gap	Multi-Lot Avg (€M)	Single-Lot Avg(€M)	Value Ratio	Strategy	Significance
1	Finland	5.56%	85.09%	+79.5 pp	197.58	2.04	97.05×	Ultra-High Concentration	p=0.091
2	Netherlands	9.52%	84.28%	+74.8 pp	217.49	4.27	50.92×	Ultra-High Concentration	p=0.047
3	France	32.65%	82.08%	+49.4 pp	40.39	4.27	9.45×	Balanced High-Frequency	p=0.001
4	Hungary	42.54%	75.26%	+32.7 pp	3,292.97	801.25	4.11×	Balanced High-Frequency	p=0.012
5	Ireland	6.52%	74.70%	+68.2 pp	34.62	0.82	42.32×	Ultra-High Concentration	p=0.001
6	Austria	11.22%	70.83%	+59.6 pp	147.73	7.69	19.20×	Ultra-High Concentration	p<0.001
7	Switzerland	3.33%	69.52%	+66.2 pp	560.46	8.47	66.14×	Ultra-High Concentration	p=0.092

8	Italy	13.33%	60.41%	+47.1 pp	49.50	4.99	9.92×	Balanced High-Frequency	p<0.001
9	Poland	35.04%	57.23%	+22.2 pp	7.54	3.04	2.48×	Balanced High-Frequency	p=0.264
10	Spain	26.17%	50.52%	+24.4 pp	4.68	1.62	2.88×	Balanced High-Frequency	p=0.313
11	Germany	12.24%	46.99%	+34.8 pp	44.18	6.96	6.35×	Balanced High-Frequency	p=0.781
12	Bulgaria	36.57%	40.51%	+3.9 pp	1.77	1.5	1.18×	Balanced Moderate	p=0.117
13	Romania	37.67%	29.27%	-8.4 pp	6.20	9.05	0.69×	SME Access	p=0.672
14	Belgium	19.39%	11.61%	-7.8 pp	4.83	8.86	0.55×	SME Access	p=0.130
15	Sweden	8.00%	10.24%	+2.2 pp	37.91	28.91	1.31×	Balanced Moderate	p=0.286
16	Greece	21.38%	8.30%	-13.1 pp	1.59	4.79	0.33×	SME Access	p=0.189
17	Czech Rep.	16.55%	6.30%	-10.3 pp	17.05	50.24	0.34×	SME Access	p=0.245

Source: Author's Compilation.

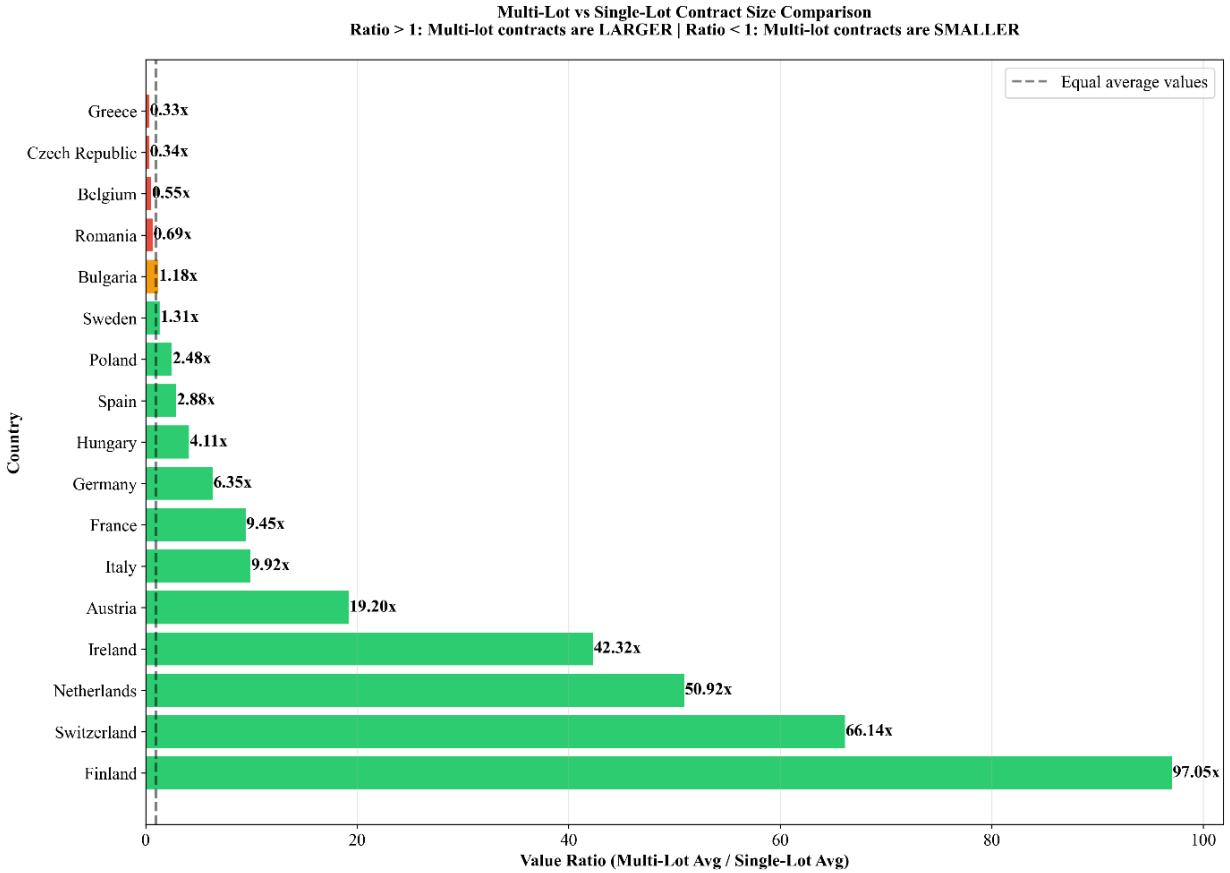


Fig. 5. Multi-Lot vs Single-Lot Contract Size Comparison
Source: Author's Compilation

Balanced moderate (ratio 0.8-2×, n=2 countries):

- Bulgaria: 1.18× ratio, 36.57% count, 40.51% value, count-value gap +3.9 pp
- Sweden: 1.31× ratio, 8.00% count, 10.24% value, count-value gap +2.2 pp

Statistical significance testing. Mann-Whitney U tests comparing multi-lot versus single-lot contract value distributions by country:

- Significant at $p<0.001$: Austria, Italy
- Significant at $p<0.01$: France ($p=0.001$), Ireland ($p=0.001$)
- Significant at $p<0.05$: Hungary ($p=0.012$), Netherlands ($p=0.047$)
- Non-significant ($p>0.05$): Switzerland ($p=0.092$), Finland ($p=0.091$), Spain ($p=0.313$), Poland ($p=0.264$), Germany ($p=0.781$), Sweden ($p=0.286$), Belgium ($p=0.130$), Bulgaria ($p=0.117$), Greece ($p=0.189$), Czech Republic ($p=0.245$), Romania ($p=0.672$)

5. Discussion

5.1 Institutional Divergence Within Formal Harmonisation

Results provide strong empirical support for North's (1990) distinction between formal and informal institutions in public procurement contexts. EU directives (2014/24/EU, 2014/25/EU) have successfully harmonised formal legal requirements—all 2,370 analysed tenders demonstrate compliance with the mandated XML schemas, TED publication protocols, standardised procedural types, and uniform timeline specifications. However, informal administrative practices—operationalised through document-observable patterns in verbosity, complexity, evaluation emphasis, and lot structuring—diverge dramatically despite identical regulatory frameworks. Section 4.1 documents extreme variation ranges spanning from 8.8-fold differences in documentation verbosity to 1,102-fold differences in contract value aggregation. The 50% country-explained variance ($\eta^2 = 0.500$) for information accessibility scores indicates that document-observable patterns are highly systematic and country-specific rather than random, confirming that these patterns reflect embedded administrative philosophies rather than measurement noise. The persistence of informal patterns despite formal harmonisation (1992-2024) aligns with institutional theory's predictions of path dependence (North, 1990; Pierson, 2000), suggesting that deeply rooted administrative philosophies resist regulatory convergence efforts. This finding challenges naive expectations that formal legal integration automatically produces behavioural convergence. While EU directives successfully mandate what authorities must publish, how authorities communicate requirements reflects deep-rooted administrative cultures operating beneath the regulatory surface. The efficiency cluster (comprising the Czech Republic, Finland, and Switzerland) spanning distinct geographic regions demonstrates that procurement philosophy can transcend geographic proximity when administrative values align, challenging conventional administrative tradition typologies that assume geographic clustering (Pollitt & Bouckaert, 2011). Beyond aggregate country effects, the analysis reveals several dimensions of extreme variation indicating fundamentally different documentation philosophies. Award criteria word counts demonstrate a 274.9-fold range (Romania: 762 words vs. Austria: 3 words; $\eta^2 = 0.193$, $p < 0.001$), reflecting variation in the written evaluation framework rather than necessarily indicating differences in evaluation sophistication. Evaluation method complexity exhibits a 199.9-fold range (Romania: 0.166 vs. Austria: 0.001, $\eta^2 = 0.266$, $p < 0.001$), measuring written complexity in tender notices through the award criteria word count (60% weight) and quality standards count (40% weight). Contract value ranges 1,102-fold (Hungary: €1,720 million vs. Bulgaria: €1.6 million, $\eta^2 = 0.092$, $p < 0.001$), although this may reflect market size and sample composition effects rather than administrative philosophy per se. Digital capability scores demonstrate an 8.6-fold range (Romania: 0.328 vs. Austria: 0.038, $\eta^2 = 0.315$, $p < 0.001$), representing the second-highest effect size. This composite score measures document-observable digital terminology through four components: digital communication emphasis (40% weight), unique digital terms count (30% weight), online platform mentions (20% weight), and digital signature mentions (10% weight). As a Critical measurement limitation, this

measures digital terminology richness in tender notices rather than actual platform usability, backend architecture, or the quality of technological infrastructure. A country with sophisticated platforms but few mentions of platforms would receive a low score, while one with extensive digital terminology but basic platforms would receive a high score. The 8.6-fold range is validly indicative of the fact that Romania's tender notices contain 8.6 times more digital terminology than Austria's, which may reduce information asymmetry for cross-border bidders. However, it would not be valid to support claims about differences in infrastructure quality. Multi-dimensional analysis enables the identification of distinctive country-specific profiles in procurement documentation. Hungary combines extreme verbosity (1,150 words, 8.8 times the European minimum) with ultra-high-value aggregation (€1.72 billion average, 1,102 times the value of Bulgaria), suggesting the need for comprehensive risk mitigation documentation for high-value contracts. Romania exhibits digital-forward documentation, with digital capability (0.328), transparency (0.370), and evaluation complexity (0.166)—all European maxima — indicating systematic and comprehensive documentation for both digital and quality dimensions. Austria demonstrates efficiency-minimalism (3-word award criteria, 274 times lower than Romania), paradoxically combined with sophisticated value aggregation (19.20 times multi-lot concentration, $p < 0.001$). Finland exhibits Nordic efficiency (265 words, low quartile) with an extreme multi-lot concentration (a ratio of 97.05 times, with 5.56% of tenders capturing 85% of the value, although the p-value of 0.091 requires validation). These profiles document systematic approaches to tender notice documentation rather than comprehensive procurement system assessments.

5.2 Implications for Procurement Stakeholders

Findings reveal systematic country-specific documentation patterns that create distinct information environments for cross-border procurement. This section offers strategic guidance for international suppliers, contracting authorities, and policymakers, grounded in empirical analysis.

For International Suppliers: Cross-border bidding requires adaptation of the country-specific information strategy. When bidding in high-verbosity documentation countries (Hungary: 1,150 words average; Romania: 788 words), suppliers should expect comprehensive technical specifications and detailed evaluation criteria to be embedded in tender notices, enabling thorough bid preparation directly from published documents, but requiring significant analysis time. When bidding in minimalist documentation countries (Sweden: 131 words; Czech Republic: 164 words), suppliers should proactively seek clarification through formal procurement queries, as tender notices provide skeletal frameworks that assume bidder familiarity with national standards and implicit requirements. The 8.6-fold difference in digital terminology (Romania 0.328 vs Austria 0.038) indicates that digital submission expectations differ substantially: high-scoring countries explicitly state mandatory digital channels and platform requirements in tender text, while low-scoring countries may assume digital literacy without written elaboration. Suppliers lacking market-specific knowledge face a 274.9-fold variation in the specification detail of award criteria (Romania: 762 words vs. Austria: 3 words), suggesting that unfamiliar markets with minimalist documentation require extensive pre-bid market intelligence to decode implicit evaluation frameworks. The efficiency cluster countries (Czech Republic, Finland, Switzerland) combine minimalist documentation with streamlined procedures, potentially offering faster tender cycles advantageous for resource-constrained SMEs, while the verbosity cluster countries (Hungary, Romania) provide comprehensive written information, reducing uncertainty but requiring greater analytical capacity.

For Contracting Authorities: The multi-lot value paradox reveals three viable strategic approaches with distinct outcomes. Ultra-high concentration strategy (Finland, Switzerland, Netherlands, Austria, Ireland) reserves lot structuring for complex, high-value contracts (value ratios of 97.05× to 19.20×), optimising administrative resources by limiting it to projects where specialised vendor coordination justifies the increased complexity. This approach aligns with risk distribution requirements for large-scale implementations (Flynn & Davis, 2014) but may limit SME access opportunities. The SME access strategy (Greece, Czech Republic, Belgium, Romania) employs lot

structuring predominantly for disaggregation, producing multi-lot contracts with lower average values than single-lot contracts (value ratios of 0.33× to 0.69×), operationalising the Small Business Act principles (European Commission, 2008) by deliberately subdividing contracts to enable smaller vendor participation. This approach maximises competition breadth but increases coordination complexity and administrative burden. A balanced high-frequency strategy (Germany, Italy, Hungary, France, Poland, Spain) systematically employs lot structuring across value ranges (value ratios 2.48× to 9.92×), treating it as standard practice rather than an exceptional tool, suggesting that administrative cultures prioritise flexibility and vendor specialisation matching. Authorities can strategically select approaches based on policy priorities, such as focusing on administrative efficiency, disaggregating for market access, or deploying resources in a balanced manner to achieve comprehensive risk distribution. Statistical significance testing indicates that only Austria ($p < 0.001$), Italy ($p < 0.001$), France ($p = 0.001$), Ireland ($p = 0.001$), Hungary ($p = 0.012$), and the Netherlands ($p = 0.047$) demonstrate statistically significant concentration effects. At the same time, Finland (97.05×) and Switzerland (66.14×) show extreme concentration ratios with borderline significance ($p \approx 0.09$), suggesting either genuine policy or minor sample artefacts requiring validation.

For Policymakers: Results suggest that targeted interventions addressing information asymmetries are preferable to intensified procedural harmonisation. An enhanced procurement intelligence infrastructure—systematically publishing country-level documentation practice benchmarks derived from TED data—could reduce cross-border information barriers by making implicit national practices explicit for international suppliers, while maintaining administrative flexibility. Minimum information provision standards for tender notices could establish baseline transparency requirements (digital channel specification clarity, minimum word counts for award criteria, technical specification completeness metrics) without mandating uniform documentation approaches, balancing single-market objectives with subsidiarity principles. The 8.6-fold variation in digital terminology suggests that standardising digital requirement documentation formats could substantially reduce information asymmetry (by explicitly stating whether digital submission is mandatory/optional, platform access procedures, and technical requirements) without constraining platform technology choices. The efficiency cluster demonstrates that minimalist documentation achieves full regulatory compliance, indicating that current directive requirements permit substantial administrative flexibility; policymakers might explicitly acknowledge this flexibility through guidance documents rather than increasing prescriptive requirements. Multi-lot strategic diversity (three distinct patterns serving different policy objectives) suggests that harmonising lot structuring procedures while permitting strategic differentiation—by ensuring clear documentation of aggregation/disaggregation rationales, transparent decision criteria for lot structure, and systematic publication of lot structuring statistics—could improve transparency without constraining policy autonomy.

Methodological Scope and Limitations: The findings derive from software procurement (CPV 48000000, n = 2,370) conducted during 2023-2024, using open tender procedures with a value exceeding €50,000. This limitation restricts generalizability to construction, smaller contracts, or alternative methods (restricted, negotiated, or competitive dialogue). Analysis measures document-observable patterns in published tender notices rather than actual procurement system quality, bidder experience, procurement outcomes, or implementation reality. The 101-parameter framework achieves 95.4% validation accuracy, but measurement noise in the remaining 4.6% affects precision. Results reveal systematic correlations between countries and documentation patterns, but they cannot establish causal mechanisms; observed variations may reflect cultural traditions, market structures, administrative capacity, political priorities, or a combination of these factors. A comprehensive procurement system assessment would require an outcome evaluation, including bidder participation rates, cross-border competition levels, procurement efficiency metrics, and contract delivery performance—data not typically available in tender notice analysis. Practitioners and policymakers should interpret findings as benchmarks for tender notice transparency and information provision rather than comprehensive assessments of system quality.

6. Conclusions

This study demonstrates that EU procurement directive harmonisation has successfully harmonised formal legal frameworks, while administrative documentation practices remain highly variable across countries. Analysis of 2,370 TED tender notices reveals that country of origin explains 50% of the variance in information accessibility scores ($\eta^2 = 0.500$), an effect size rarely observed in social science research. Multi-level hierarchical clustering identifies five distinct documentation strategies: Extreme Verbosity (Hungary), Multi-Domain Integration (Romania), Efficient Minimalism (Czech Republic, Finland, Switzerland), Western/Nordic Mainstream (Austria, Belgium, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden), and Eastern/Southern Moderate Complexity (Bulgaria, Greece, Poland). These findings are derived from document-observable parameters that measure what is written in published tender notices, rather than the underlying procurement system implementation, thereby limiting conclusions to documentation practices and information provision patterns. Results empirically validate institutional theory's formal/informal distinction (North, 1990; Pierson, 2000; Pollitt & Bouckaert, 2011): EU directives harmonise formal legal procedures while informal administrative practices—embedded through path-dependent historical development—resist convergence. Documentation culture operates hierarchically, with country-level effects explaining substantial variance (macro-level) and strategic clusters transcending geographic boundaries (meso-level), challenging simplistic culture-as-geography assumptions prevalent in cross-national public administration research. The five-strategy typology demonstrates both extreme divergence (Hungary and Romania as outliers) and nuanced differentiation within the mainstream (three meso-level clusters), validating the necessity of multi-level analytical approaches for understanding administrative diversity. Methodologically, this research pioneers the application of large language model reasoning capabilities to extract nuanced administrative patterns from unstructured, multilingual procurement documents at scale. The hybrid architecture utilises Claude 3.5 Sonnet, selected for its superior semantic understanding, to perform context-aware extraction across 18 European languages, capturing subtle administrative nuances that rule-based systems cannot detect. The approach achieves 95.4% expert validation accuracy across 2,370 tenders and 101 parameters while implementing comprehensive anti-hallucination frameworks (double-calculation verification, constituent parameter validation, evidence traceability). This establishes a replicable blueprint for systematic document-to-intelligence transformation applicable beyond procurement to policy analysis, regulatory compliance assessment, and cross-national administrative research. The 101-parameter framework demonstrates that LLM-based extraction can achieve human-expert-level accuracy in nuanced semantic tasks across multiple languages and administrative contexts. Findings inform international suppliers navigating cross-border information asymmetries, contracting authorities selecting among three viable lot structuring strategies (ultra-high concentration, SME access, balanced high-frequency), and policymakers designing "unity in diversity" frameworks that distinguish harmonizable procedural dimensions from legitimately diverse administrative philosophies. The multi-lot value paradox—20.46% of tenders capturing 71.99% of the value—reveals sophisticated economic differentiation invisible to frequency analysis alone, demonstrating that identical regulatory frameworks permit substantially different strategic implementations that serve distinct policy objectives. Future research extensions would strengthen understanding: longitudinal analysis assessing convergence trajectories over time; cross-domain validation extending the methodology to construction, supplies, and general services procurement; outcome research linking documentation patterns to procurement performance metrics (competition levels, vendor participation rates, contract execution success); qualitative research employing interviews with procurement officials and suppliers illuminating cultural mechanisms; and global expansion to non-European contexts testing whether formal/informal divergence patterns transcend EU-specific institutional environments. This research establishes the broader principle that administrative culture—operationalised through document-observable practices—exhibits path-dependent resistance to formal harmonisation efforts. Understanding these persistent differences in

documentation is crucial for designing effective single-market integration policies that respect legitimate administrative autonomy while ensuring sufficient transparency of information to facilitate cross-border competition. As digital transformation accelerates across European public administration, these findings provide an evidence-based foundation for balancing harmonisation objectives with administrative diversity, ensuring that the single market serves both efficiency and subsidiarity principles.

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